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EFFECT OF VARIOUS MINIMAL PROCESSING TREATMENTS ON QUALITY CHARACTERISTICS AND NUTRITIONAL VALUE OF SPINACH

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Vegetables are highly nutritious and value able part of our diet and the market sale of ready-to-use fresh vegetables grown rapidly as a result of consumer attitude. Many health benefits also related so its consumer and economic value increasing day by day. Fresh-cut or minimally processed vegetable means to washed, peeled, trimmed or sliced the vegetable into required size, chemically treated, packed into packaging material and finally stored in refrigerating temperature. Minimally process vegetables may also be considered as healthy vegetable with availability of their maximum saved nutrients. In present project spinach is selected to minimally process due to its rich nutritional contents and higher use in our daily life for the production of variety of products. Moreover nutrients like iron, calcium and vitamin K are present in higher concentrations due to which it become more beneficial against some serious health problems like of anemia, hemorrhage, clotting dysfunction and to maintain electrolytes balance in our body.
Keywords: Vegetables, Ready-To-Use, Fresh Cut, Minimal processing, Vitamins, Minerals

INTRODUCTION

Vegetables are versatile and enrich portion of human foods. They are the primary source of minerals, vitamins, plant metabolites, and other components which are helpful for health and nutrition of human beings. Although vegetables account for less than 1% of the world's plants, anatomical, the genetic, and morphological diversity of vegetables as a group is surprising (Watkins CB,2008; Wismer 2003).

Production of spinach: Spinach (*Spinacia oleraceae*) is an important leafy green vegetable of Amaranthaceous - *Chenopodiaceae* family. There are 1400 species along with 102 genera. Out of which (*Spinacia oleraceae*) is most common specie being its official scientific classification name. Spinach *(Spinacia oleracia*) is thought to be native to Central Asia (Tsao and Lo, 2004). Moreover this is one of cool-season vegetables and can be grown in temperate regions all year around with a short grown period of 30-35 days (Conte *et al*., 2008). Optimum growth temperature is 15-20 ^{o}C (Tsao and Lo, 2004). China is major producer of spinach followed by United States, Japan and Turkey. As green leafy vegetable spinach can be consumed either after boiling, baking and can also be used as raw baby spinach leaves in salad (Ismail *et al*., 2004).

During 2009-10, in Pakistan, the annual production of fruits and vegetables were 13.67 million tonnes. Spinach production in Pakistan in 2011 was 103.446 tons. Area under spinach cultivation was 8.167 hectares. In hectogram yield of spinach was126.663 per hectare during the year 2011. It has been reported that about 30-50% of fruits and vegetables are wasted after harvesting during transportation, storage and processing in developing countries (Alzamora *et al.,* 2000).

Nutritional benefits of minimally processed vegetables: Vegetables are highly important for their mineral and vitamin content. The WHO recommended the consumers to: eat at least 3 servings of vegetables 2 servings of fruits every day. Choose fresh, frozen, dried, or canned vegetables especially dark-green leafy vegetables must be incorporated. Vegetables also having phytochemicals that functions as antioxidants, detoxifying agents prevent tumor growth and helps to modify metabolic process. Antioxidants are the biologically active compounds those at minute concentration provide the oxidative stability to the higher amount of lipid and DNA. Antioxidants like mangiferin provide protection to cell from oxidation and react with radicals (Tachakittirungrod *et al*., 2006).

Large amounts of minerals and vitamins are present in spinach. Water soluble vitamins, Vitamin A, and several minerals like calcium, phosphorus, iron and potassium are present in spinach. Spinach also contains higher levels of protein and dietary minerals. Spinach is highly perishable thus it contains ninety one percent of water in its total weight. 3.2 grams of protein, 4.3 grams of carbohydrates, and 0.3 grams of fat are present in single serving of spinach. Spinach contains vitamin C, Vitamin A, riboflavin, niacin and thiamin. Among minerals calcium, phosphorus, iron, sodium, and potassium are also found in spinach greens. Vitamin C is most important constituent of spinach and also known as antioxidant (Wang *et al*., 2007). Total lipid content of spinach is 0.39% with a high 18:3 content of 50.138% .Spinach has high level of moisture content

(91.4%). (2.2%) dietary fiber content is also present in spinach.

Requirements of minimally processed vegetables with respect to spinach: Minimally processed product refers to washed, peeled, trimmed, sliced into required sizes/slices, the fruits and vegetables and treated with suitable method and packed in sterilized packaging materials made up of glass and finally they are subjected to store in refrigerated condition (IFPA, 2004). This technology is also being known as fresh-cut, partially/lightly processed and value added foods. Main objective of adopting the fresh-cut, minimally processed technology is to increase its availability in market for longer time in fresh form. In recent era fresh cut fruit and vegetable industry is rapidly increasing, reason behind this is always demand of consumer. Minimally processing techniques fulfilled the demand of consumers by controlling microbial growth as well as enzymatic browning (Allende *et al.,* 2006). Minimally processed products represent high quality color, flavor, aroma and overall acceptance. Changes in lifestyles of consumers have led to a greater variation among their choice and behavior towards food acceptability. Fresh-cut and minimally processed foods offer advantages to food `companies and restaurants over using traditional products (Medina *et al*., 2012).

Perishable vegetables are very sensitive so, a good care is required to handle them before and during storage. Careless and improper handling of spinach reduces the keeping quality and market share. Almost half of product goes to waste after harvesting. Decay of vegetables can be reduced by using good postharvest technologies. Pathogenic attack cause most troubles in spinach (Corzo and Gomes, 2004).

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Consumers generally purchase minimally processed products for expediency, fresh quality, nutritional aspect, food safety and the eating habits. Demand of consumers for quality parameters brought a positive change in minimally processed industry. These products provide the consumers a single packet or a box that contain a variety of foods. Minimally processed products reduce the wastage of time at the domestic level. In this way they provide the consumer to attain only the quantities of fresh products they needed. A very little product transformation is required for the production of minimally processed vegetables. Investment in technology, equipment and management systems is required. Strict laws of food safety principles and practices are required to ensure product quality (Fellows, 2000).

Problems of minimal processing vegetables

Rate of Respiration: Respiration is the primary metabolism that can affect and limit the life span of fruits and vegetables their quality and nutrition changes during storage (Able *et al*., 2003; Bron *et al*., 2005; Porter *et al*.2005.)

Major problem related with minimally processed spinach is development of off flavor. In a comparative study, it has been reported that spinach has a high respiring rate when stored in any suitable package; hence it requires high level of oxygen. However low oxygen level and elevated level of carbon dioxide not only lower respiration but also decrease deterioration.

Respiration of vegetables continues it causes quality deterioration and nutrition diminution. Most of the vegetables contain higher water content (b/w 65% and 96%). So they easily lose water during storage due to transpiration of water. This leads to quality deterioration of fruits and vegetables and also loses their commercial value.

High rate of respiration can cause great loss of nutritive quality, flavor, and acid. Rate of respiration can be lower down by storage at5 C below or. There are some other factors which enhance rate of respiration other than temperature. Green leafy vegetables having high rate of respiration than a fully mature vegetable like onion (Bishop *et al*., 1997).

Ethylene production: Production of ethylene starts from few minutes to half an hour after cutting. Rate of production is relatively higher between 6 and 12 hours. Ethylene can build up in packages of minimally processed vegetables, leading to unattractive quality during the storage (Saltveit *et al.,* 2005). After cutting the exposed surfaces of vegetables shows high level of ethylene production. Respiration process is also stimulated and phenolic metabolites are formed. Ethylene production also stimulate Phenylalanine ammonia lyase (PAL), is an enzyme that catalyses the formation of phenolic compounds. Ethylene and other hormones induce senescence to the leaves on the tree, but apparently not in all growth phases. Results indicate that in very young leaves, ethylene is not able to induce leaf senescence, but when the leaves reach a certain level of maturity, ethylene will induce senescence, and as senescence is progressing, the process will run independently of ethylene presence (Fan *et al.,* 2000). Harvested leafy vegetables produce small amounts of ethylene; however, senescence is accelerated if they are stored together with ethylene producing products (Ludford, 2003; Martinez-Romero *et al*., 2007; Whitaker, 2003). Ethylene can also motivate and accelerate wounding of membranes, loss of chlorophyll and vitamin C, toughening, and undesirable flavor changes (Kader, 2005). Production of ethylene is very low in minimally processed vegetables is less than fresh vegetables.

Water loss: Water loss can cause shriveling and rapid quality loss of fresh lettuce young green leafy vegetables (Cantwell *et al*., 1998; Wang, 2003). Agüero *et al*. (2011) observed reduction in quality parameters of lettuce and salads when they stored at low RH (70-72%). They also pointed out the importance of preventing the vegetables from dehydration and keeping fresh even after their harvesting.

Medina *et al*. (2012) explained that relative humidity also has an effect on spinach after minimally processing. The organ of plants that are originated from parent plant cannot replenish their moisture (Ben-Yehoshua and Rodov, 2003). Excess loss of water and tissue moisture keeps the harvested commodity in stress during storage condition. Surplus turgid pressure caused either by absorption of external water or by water distribution within different fruit tissues may influence shelf life(Ben-Yehoshua and Rodov, 2003). On applying cut to vegetable, the surface of flesh is exposed which results in enhancing the evaporation rate. The loss of moisture from fruits varied according to their nature (Watada and Qi, 2001). Reduction of tissues and increasing the surface area of vegetables are two important issues in increasing the rate of moisture loss. So on wounding, fruits surface area increases which become the reason of rupturing the vegetable tissues and rapid moisture loss.

Textural changes: The texture of vegetable vegetative tissue is dependent on the cell wall, turgor and the structure of the tissue. A young leaf has mainly primary cell walls, and as baby leaves are in the expansion phase), the cell walls are not fully developed, and the tender tissue of baby leaves leads to faster texture loss and decay than experienced in spinach (Martinez-Sanchez *et al*., 2010). If no attempts are made against water loss, leafy vegetables will wilt and in case of a product like Spinach, wilting of surfaces can be the major reason to loss of visual appearance and texture stability (Piagentini *et al*., 2002). Wilting happens due to the transpiration processes and if leafy vegetables lose more than 3% of the original fresh weight, they become unsalable (Ben-Yehoshua and Rodov, 2003).

Water loss that induces physiological stress, enhance senescence of tissues. Higher rates of membrane destruction and cellular contents leakage also occur due to transpiration (Ben-Yehoshua and Rodov, 2003). When the structure of the leaf is broken, the leaf will be more vulnerable to attack from microorganisms, and even in freshly harvested parsley, cracks in the waxy cuticle can be detected (Wood *et al*., 2005). In these cracks, microorganisms can develop and lead to rot. The cell rupture and general degradation of tissue lead to release of odorous compounds (Jacxsens *et al*., 2003; Nielsen *et al*., 2008), and development of different off-odors was also experienced in the green leafy vegetables.

Oxidative/enzymatic browning: Browning pigments on surface or color disturbance are one of the main drawbacks of minimally processed vegetables. They results to quality loss in fresh-cut produce. It may occur due to PPO enzyme oxidation of phenolic substrates. (McEvily *et al*. 2002). The degree of browning reaction is always relies on the available concentrations of active PPO enzyme and phenolic compounds in the plant tissue. pH, temperature and oxygen available to the tissues are responsible for these reactions (Kader, 2002). High level of PPO enzyme is present in plant tissues. Levels of PPO enzymes production and substrates changes with the whole life of vegetables. Carotenoids are yellow colored pigment most abundantly found in fruit and vegetable leaves and peel, are readily vulnerable to oxidative broccoli. Shelf life of spinach is highly reduces due to yellow discoloration. Different treatments are used for inhibiting the browning reactions from vegetables, modified atmosphere packaging that lower the oxygen and use of sulfites chemical inhibitors. (Saltveit 2000). Ascorbic acid is found to be an effective substance to reduce enzymatic browning. It reduces the formation of quinines. The enzymatic browning by action of PPO is not limited to discoloration, unwanted tastes but can also be involved in loss of nutrients (Vamos-Vigyazo, 2004). The first browning reaction by PPO result in the creation of O-quinones (slightly colored), then convert to complex brown pigment through oxidation non-enzymaticaly. O-Quinones can react with other phenolic compounds, quinine molecules. Amino groups of peptides and proteins of amino acids can also react with them (Nicolas *et al*., 2007; Whitaker and Lee, 2001). Usually from this process brown pigments are formed along with some other colors like radish-brown and blue-gray. Phenolic compounds that are involved in the reaction are responsible for the development of color pigments (Amiot *et al*., 2000).

Susceptibility to microbiological spoilage: Minimally processed vegetables showed a very small number of microorganisms. Numbers of microorganisms are deliberately high in unwashed vegetables. Number of microbial population enhance during peeling, cutting, slicing and shredding (Akbar *et al*., 2006).Barrera *et al*. (2012) investigated that processing parameters having an influence on the efficiency of commercial post-harvest biocide washes to lower down the bacterial contamination.

Medina *et al*. (2012) explained that relative humidity also has an effect on spinach after minimally processing. An experiment was performed which showed when different conditions of RH are applied to the minimally processed spinach. Spinach sample that was given high relative humidity showed higher electrolyte seepage from leaves, higher respiration rate that resulted in leaf damage. Damaged leaf resulted in shorten the shelf life of minimally processed spinach.

Spoilage of minimally processed vegetables by bacteria is characterized by the presence of brown or black discoloration. However, production of off-odors, softening of texture, loss of flavor also associated with bacterial spoilage. Vegetables usually undergo fermentative spoilage by lactic acid bacteria or yeasts and water loss due to vascular infections (Heard 2000). In addition to the use of several chemical substances, different bio preservatives are used to prevent the microbial spoilage of minimally processed vegetables. (Haye *et al*., 2008; Allende *et al*., 2007; Brown *et al*., 2011; Leverentz *et al*., 2006).

Minimally processed vegetables are susceptible to microbial growth because they are cut parts of vegetables. Mesophilic bacteria, lactic acid bacteria, co-liforms, yeasts and molds can be a vehicle for the transmission of bacterial, parasitic,

and viral pathogens causing disease (Ongeng *et al*. 2006). The micro flora of fresh-cut vegetables is the environmental pollutant consequently; it is predictable that the products contain very small amount pathogenic agents (such as Bacillus cereus and Listeria monocytogenes) from environment. In recent years the presence of food borne illness caused by pathogens were lowered (Mukherjee *et al*.2006).

The pathogens mainly related to outbreaks include bacteria (Salmonella) of microorganisms has been found on package of minimally/fresh-cut processed food products. These include coli forms, lactic acid and mesophilic bacteria, mold and yeast which actively grow on packed fresh-cut fruits and vegetable products (Carlin and Nguyen-The, 2007). Increase in microbial populations on fresh-cut produce in packed fruits and vegetables are closely related to increased respiration process during storage in the presence of oxygen with the result of their rapid spoilage (Varoquaux *et al*., 2000a; Lamikanra, 2002).

Nutritional changes in minimally processed vegetables: Vegetables hold smaller to larger amounts of a number of significant nutrients such as carbohydrates, vitamins and minerals etc. Besides the major or macronutrients some minor or micronutrients such as organic acids are very important involve in raising the appearance, taste, flavor, color and aroma of fruits through making combination with the sugar content. The aroma of fruit and vegetable is formed by the esters of aliphatic alcohols and short chain fatty acids. (Camire, 2000; Lamikanra *et al*., 2005). Nutritional characters of fruits and vegetables are formed by vitamins, mainly vitamin A, B, C, thiamine, niacin. Minerals and dietary fibers also supply nutritional characters. Compounds such as carotenoid pigments, polyphones, flavoinids and other phytonutrients are present in plant tissues. They are associated with lowering the cause of cancer and cardiovascular diseases in humans. According to Gil *et al*., (2006), minimally processed vegetables and fruits can appear visually blemished when there is no nutrient loss occurs. In the future, there are expectations that plant-breeding techniques may be effective to develop cultivars with enhanced nutritional characters that are able to survive the effects of processing.

Ways to improve the quality and shelf life of minimally processed vegetables: The demand for minimally processed fruit and vegetables is growing with the demand for nutritional quality as close as fresh. In minimal processing through cutting, the vegetables tissues many undergo physiological disorders or may initiate the nutrient retention as compared with whole vegetables during storage (Rico *et al*., 2007). To enhance the shelf-life of minimally processed vegetables, as well as to preserve their nutritional quality and to assur the food safety, high quality raw material, some chemical additives are required (Ninfali 2004).

Use of Firming Agent: Calcium and its respective salts especially calcium chloride and calcium lactate has been well known as firming agents involved in delaying the firmness of produce. Calcium ions form a link or bridge with free carboxyl groups of the pectin chains, resulting in strengthening of the cell wall (Lamikanra, 2002). Treatment of calcium is frequently used in the industry as firming agents for vegetables like tomatoes, cucumber and spinach. The calcium effects on firmness, explored through different means like: creating the involvement of calcium ions along middle lamella pectin and cell wall, stabilizing the cell membrane with calcium ions and by checking the effect of calcium ion on turgor pressure of cell (Luna-Guzman and Barrett, 2000). Calcium ion can also act as reducing the action of polyphenol oxidase 13 PPO) along with its respective substrates from the fresh-cut surfaces through reducing the browning (Lamikanra, 2002) problem from fruits.

Calcium chloride is an effective agent in slowing the maturity process to soften the tomato in packaging material while stored at 2°C and 10°C (Artes *et al*., 1999). In fact, this could be due to the inhibition of responsible enzymatic activity by the action of chloride ion. Concentration of calcium chloride from 1 to 5% inhibits the wounds of minimally processed vegetables caused by respiration process. They noticed that calcium chloride could not control the generation of ethylene gas (Luna-Guzman and Barrett, 2000). Luna-Guzman *et al* (2001) found that the firmness considerably decreased with the increase of calcium chloride up to 4% due to some stress given to vegetable tissues which results in rapid increase in respiration and ethylene production. Similarly, Krishna and Babu (2002) reported that the bitterness in fruits starts to increase with the use of calcium chloride more than 3%. Moreover on treating cantaloupe with 2.5% calcium chloride and 2.5% calcium lactate, Luna-Guzman and Barrett (2000) found that both salts maintained firmness of cantaloupe throughout the cold storage but it was calcium chloride, which impart undesirable bitterness to fruit slices instead of calcium lactate.

Use of Anti-browning agents: Numerous types of chemical additives are used for reducing the browning problem in fruits and vegetables. Some of them may directly act as polyphenole oxidase inhibitors, others cause to be the medium insufficient for the development of the brown pigmentation. Anti-browning agents reacts with the products of PPO reaction. They reduce the ability of browning pigments before their formation.

Use of Reducing agents: Reducing agents are highly active in minimizing or inhibiting the browning problem in fruits and vegetables (Lamikanra, 2002; Marshall *et al*., 2000). They function against the production of quinones compound that are formed by irreversibly linkage with copper of enzyme during the action of polyphenole oxidase enzymes with phenol compound in the presence of environmental oxygen.

Use of Ascorbic Acid: Ascorbic acid exists mostly in reduced form in leaves and chloroplasts and well known antioxidant or anti-browning agents, acidic in nature, soluble in water and forms neutral salts (Alzamora, 2000; Soliva-Fortuny *et al*., 2003). Mostly used phenolase suppressor by reducing *o*-benzoquinones return back to *o*-diphenols. It also has a direct effect on polyphenol oxidase enzyme (Whitaker, 2003; Golan-Goldhirsh *et al*., 2002). Ascorbic acid is also considered as a nutritive agent (vitamin C). Vitamin C acts as a strong reducing agent due to its ability its chemical, physiological and biochemical actions are well known. Gorny *et al.* (2000) observed that browning can be reduced by using 1% calcium lactate and 2% ascorbic acid in minimally processed vegetables up to 8^{th} day while stored at 0°C. Gil *et al* (1998) observed that browning reactions in spinach leaves can be controlled by the application of 2% ascorbic acid. Sanchez-moreno and Elez *et al*. (2005) declared that rancidity of fats and oils can be controlled by using 200 mg/l ascorbic acid. Ascorbic acid is also helpful to reduce the rancidity of fruits and vegetables purees. Esparza *et al* (2005) found that overall acceptability and flavor quality of green leaf lettuce was highest when treated in a 1% ascorbic acid solution for two minutes and stored for 14 days interval at the temperature of 5^oC in sealed polyethylene bags.

Use of Citric Acid: Citric acid as organic acid can also become helpful in controlling the physiological changes in the group of the minimally processed vegetables. Citric acid solutions are use for dipping as their pH is relatively low so they reduce peeling loss. They caused significant micro-machining of the surface cut and peeled carrots due to destruction of the enzyme responsible for the process of lignifications (Maul *et al*., 2000). Citric acid is a phenolase Cu-chelating agent and hinders polyphenol oxidase (PPO) due to its property to act as a chelating agent (Jiang *et al*., 1999). The significant effect of citric acid in limiting the development of food spoilage and pathogenic microorganisms is widely accepted (Banwart, 1989; and Golden, 1989). Lattanzio *et al* (1989) observed that either citric acid is used or ascorbic acid is used they are equally helpful to improve the quality of vegetables. They are also beneficial to extend the shelf life of stored vegetables. They also noticed by using any acid from these two there was a stoppage of browning reaction in the treated plant material. Treating slices of lettuce with 1% or 2.5% citric acid before packaging gave limiting effect in browning.

Assimo poulou *et al* (2005) observed that highest antioxidant activity in sunflower oil was obtained with Pistacia lenticels resin (500 mg/l + citric acid 300 mg/l), followed by P. lentiscus resin (100 mg/l + citric acid 200 mg/l). Both citric and ascorbic acid are also beneficial in improving the quality, shelf-life and delaying of browning reaction of the artichoke heads stored in closed polyethylene bags after two or four weeks (Lattanzio *et al*., 1989). Post-harvest dipping in 150 and 300 mg/l ascorbic acid solution lowers over-ripening, enhanced TSS but do not affect acidity and ascorbic acid content in vegetables (Ziziphus mauritiana Lamk.) during storage (Siddiqui and Gupta, 1995).

Use of Heat treatments: Heat treatments are use in fruits and vegetables for different purposes like to minimize ethylene synthesis, reduce degradation chances of cell wall linked with hydrolytic enzymes. Especially to control or eliminate the maximum number of microbes present in them. Heat treatments are extensively used to enhance the storage period of minimally processed vegetables. (Lamikanra *et al*., 2005).As pre-treatment application of relatively low heat treatment was given to lettuce and other vegetables by Abreu *et al* (2003) and stored at 2^oC for seven days and found best treatment of 36-45°C temperature for 40 minutes treatment than other treatments in maintaining firmness of vegetables for longer storage time. Ripening processes with reduced moisture loss.

Blanching: Blanching is a significant process for vegetables in which hot air, water, or steam having temperature about $88\text{-}99^oC$ can be used to heat the product. Blanching is preferably preformed to: (1) inactivate such enzymes that are responsible for quality degradation such as texture and color changes; (2) remove air from the raw vegetables before packaging which results in better filing inside the package or can and reduces chances of corrosion by reducing excess oxygen from the headspace;(3) prevent browning problems in certain food products;(4) plays a role to preheat the product before sealing; and (5) used to soften the food product and make it easier to fill in containers. For blanching, the product can either be directly placed in hot water. Products may be conveyed through belt and exposed to hot water or steam. Vegetables tissues can bear direct heat from water thus vegetables require 100^oC for 90 seconds. Initial lipoxygenases activity can be reduced by 99% (Gupta *et al.*, 2006). Blanching is not always very suitable for fruits and vegetables, sometimes very toxic effluents are generated by blanching in canning plant. Microwave heating can also use for blanching and there are probable chance to control the problem of effluents generation.

Packaging: One important aspect of modified atmosphere packaging is maintenance of high relative humidity and promote visibility of product to consumers through condensing the amount of water which is required for growth of microbes. We should consider two things in selection of the film involves water vapor transmission rate and incorporation of anti-fog additives (Lamikanra *et al*., 2002). Another benefit of modified atmosphere packaging is attained on reducing the chance of browning of fruits through retarding the respiration rate by decreasing oxygen and increasing the carbon dioxide concentration in the packed environment.

Allende *et al*. (2006) studied the effect of MAP, super atmospheric O_2 on plant metabolism organoleptic properties and microbial growth on minimally processed vegetables. In packaging materials, in vegetables changes occurred due to

effect of packaging material and oxygen transmission levels. A good packaging material must has good permeability qualities.

CONCLUSION

The above discussion concluded that minimally processed vegetables are becoming more important segment of food industry. These processed vegetables are prepackaged for consumer convenience and to retain the vegetable freshness. In order to minimize the loss of quality and to control microbial growth, and thus ensure product safety and convenience, a hurdle approach appears to be the best method. Although minimally processed vegetables has some problems but it accomplish the increasing demand of consumers.

Future prospects: It is possible that, in the near future fruits and vegetables projected for minimal processing will be cultivated in particular controlled conditions and moreover plant geneticists will develop hybrid varieties modified to specific requirements of minimally processing. It will ensure that the practices and methods use in minimally processing should be excellent to minimize the problems.

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